Does Advanced Imaging Help in the Detection of CRC?

Prof. Nadir Arber
The Tel-Aviv Sourasky Medical Center
Tel Aviv, Israel

ESMO-GI, Barcelona 2016
My Financial Disclosures:
Bayer
Takeda
GI View
Micromedic
Bio View
Check-Cap
Bio-Explorer
Nucleix
Different Screening Modalities

- Blood tests *(Septin9, Medial, CD24)*
- Stool Tests *(FOBT, FIT, Cologuard, M2-PK)*
- Sigmoidoscopy
- Colonoscopy
- CT-colonography
- Capsule endoscopy *(Medtronics, Check-Cap)*
In 2016
Any Screening Modality is Better than Nothing

But colonoscopy is still the best option....
Reduction in CRC mortality with Colonoscopic Polypectomy: 53%

2012: NPS long-term F-U (up to 23 yrs)
He is perfect......
She is perfect......

But colonoscopy is not perfect...
Adenomas are missed...
**~20% Adenoma Miss Rates in Tandem Colonoscopies**

### RCT Tandem Studies (per lesion analyses)

- **Rex et al.** *Gastro* 1997  
  N=183  
  SFV 24% vs. SFV 31.4%  
  TER 18.4% vs. SFV 22.6%  
  *P*<0.0001

- **Van Rijn et al.** *AJG* 2006  
  N=465 (meta-analysis)  
  SFV 22.0% vs. No report

- **Leufkens et al.** *GIE* 2011  
  N=349  
  SFV 31.4% vs. SFV 22.6%  
  TER 18.4% vs. TER 45.8%

- **Gralnek et al.** *Lancet Oncol*  
  N=185  
  SFV 41% vs. SFV 8%  
  FUSE 7% vs. FUSE 69%  
  *P*<0.0001
Thus Interval CRC Can Occur...
Why Do We Miss Adenomas?

- Inadequate colon prep
- Flat/depressed lesions
- Colon anatomy (proximal folds and flexures)
- Suboptimal technique
  - Short withdrawal time
  - Missing cecal intubation

- Current technology limitations
  
  Low ADR
Detection of Small Low-risk Adenoma is the Major Driver of ADR Improvement

Trends in Adenoma Detection Rates During the First 10 Years of the German Screening Colonoscopy Program


German screening colonoscopy program
4.4 million colonoscopies in a ten year period (2003-2012)
Age-adjusted rates of adenoma detection

Brenner H, Gastroenterology 2015; 149: 356-266
**Colonoscopy-based CRC screening**

186 endoscopists
46,032 subjects
188,788 persons-years
42 interval cancers

**Interval cancers according to ADR:**

<table>
<thead>
<tr>
<th>Endoscopist ADR</th>
<th>HR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 20%</td>
<td>1</td>
</tr>
<tr>
<td>15-19.9%</td>
<td>12.50 (1.5-103.4)</td>
</tr>
<tr>
<td>11-14.9%</td>
<td>10.75 (1.3-85.0)</td>
</tr>
<tr>
<td>&lt; 11%</td>
<td>10.94 (1.3-87.0)</td>
</tr>
</tbody>
</table>

*Kaminski MF, N Engl J Med 2010; 362: 1795-803*
ADR Variation and Risk of CRC Death:

Each 1% ADR increase = 5% decrease in CRC death

See Better
Extra Wide Angle View Endoscope
Extra-Wide-Angle-View Colonoscope

- Extra-wide angle (232°)
- One screen
- Polyp detection

- All polyps 68% vs 51%, p<0.0001
- Hidden polyps 62% vs 47%, p<0.0009

Uraoka et al. Gastrointest Endosc 2013
330° Field of View
# The Fuse Study

*Gralnek et al. Lancet Oncol 2014*

<table>
<thead>
<tr>
<th></th>
<th>SFV followed by Fuse (n=88)</th>
<th>Fuse followed by SFV (n=97)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, years (mean ± SD)</strong></td>
<td>55.9 ± 9.5</td>
<td>55.7 ± 9.7</td>
<td>0.88</td>
</tr>
<tr>
<td><strong>Gender, female (%)</strong></td>
<td>46 (52.3%)</td>
<td>55 (56.7%)</td>
<td>0.55</td>
</tr>
<tr>
<td>Ottawa Bowel Preparation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score (mean ± SD)</td>
<td>3.4 ± 2.6</td>
<td>3.4 ± 2.8</td>
<td>0.89</td>
</tr>
<tr>
<td><strong>Indication for Colonoscopy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screening n, (%)</td>
<td>53 (60.2%)</td>
<td>50 (51.5%)</td>
<td>0.24</td>
</tr>
<tr>
<td>Surveillance n, (%)</td>
<td>16 (18.2%)</td>
<td>20 (20.6%)</td>
<td>0.68</td>
</tr>
<tr>
<td>Diagnostic Evaluation n, (%)</td>
<td>19 (21.6%)</td>
<td>27 (27.9%)</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>Additional Adenomas</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detected</td>
<td><strong>69%</strong></td>
<td>8%</td>
<td><strong>p&lt;0.0001</strong></td>
</tr>
<tr>
<td><strong>Adenoma Miss Rate</strong></td>
<td><strong>20/49 (40.8%)</strong></td>
<td>5/67 (7.5%)</td>
<td><strong>p&lt;0.0001</strong></td>
</tr>
<tr>
<td><strong>ADR</strong></td>
<td><strong>30/88 (34.1%)</strong></td>
<td>34/97 (35.1%)</td>
<td>0.89</td>
</tr>
</tbody>
</table>
FUSE Study Investigators - Italy

Arnaldo Amato\(^2\), Andrea Anderloni\(^3\), Franco Armelao\(^5\), Arrigo Arrigoni\(^1\), Maurizio Cavina\(^6\), Giovanni DePretis\(^5\), Gianpiero Manes\(^4\), Gianni Miori\(^5\), Alessandra Mondardini\(^1\), Franco Radaelli\(^2\), Alessandro Repici\(^3\), Romano Sassatelli\(^6\), Nereo Segnan\(^8\),
Cesare Hassan\(^7\)

Endoscopy Unit, AOU Città della Salute e della Scienza – Ospedale San Giovanni Antica Sede, Turin\(^1\); Endoscopy Unit, Ospedale Valduce, Como\(^2\); Endoscopy Unit, Istituto Clinico Humanitas, Rozzano (Milan)\(^3\); Endoscopy Unit, Ospedale di Circolo, Rho (Milan)\(^4\); Endoscopy Unit, Ospedale S Chiara, Trento\(^5\); Endoscopy Unit, IRCCS S Maria Nuova, Reggio Emilia\(^6\), Endoscopy Unit, Ospedale Nuovo Regina Margherita, Rome\(^7\); AOU Città della Salute e della Scienza, CPO Piemonte, Turin\(^8\).
FUSE vs. Standard Endoscopy in Organized Programs - RCT

Total
n= 700 (FIT+)

FUSE
n= 350

ADR
42.7%

Adv.
ADR
19.5%

Standard
n= 350

ADR
43.9%

Adv.
ADR
23.3%
ARRIVING FALL 2016
Third Eye Retroscope

- Device that passes through scope channel
- Automatically retroflexes $180^\circ$
- Provides forward and backward view simultaneously on side-by-side monitor

Courtesy of Prof. Jerry Way
**TER: Leufkens et al. GIE 2011**

<table>
<thead>
<tr>
<th>N=349</th>
<th>Adenoma Miss Rates</th>
<th>Additional Adenomas Detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFV colonoscopy</td>
<td>SFV 31.4%</td>
<td>SFV 22.6%</td>
</tr>
<tr>
<td>VS.</td>
<td>TER 18.4%</td>
<td>TER 45.8%</td>
</tr>
<tr>
<td>Third-Eye Retroscope</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Limitations of Third Eye:**

1. **Not user friendly**
2. **Takes up working channel**
3. **Increases procedure time**
4. **Costs**
Third-Eye Panoramic

- Pilot and feasibility
- Single use device
- CMOS chips, LEDs
- N=17
- 100% cecal intubation

Rubin et al. DDW 2014 abstract
Single Use, Self Propelling, Self Navigating Colonoscope
New Scanner with 2 Working Channels

Two Working Channels

2.1 mm channel Supports various 1.8mm tools
Aer-O-Scope™ Key Advantages

- **OMNI-directional 360° vision**
- **Joystick controlled self propelled colonoscope**
- **Scanner induces lower pressure on the colonic wall**
- **Extremely safe system**
- **Disposable**
- **Single operator**
- **The only available FDA approved self propelled colonoscope**
Capsule Endoscopy
### TABLE 2. Accuracy characteristics for detection of patients with at least one lesion $\geq 6$ mm or $\geq 10$ mm

<table>
<thead>
<tr>
<th>Polyp size, mm</th>
<th>Prevalence, no. (%)</th>
<th>Colonoscopy</th>
<th>PillCam Colon 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\geq 6$ mm</td>
<td>45 (41)</td>
<td>84 (74-95)</td>
<td>64 (52-76)</td>
</tr>
<tr>
<td>$\geq 10$ mm</td>
<td>32 (29)</td>
<td>88 (76-99)</td>
<td>95 (90-100)</td>
</tr>
</tbody>
</table>

CI, Confidence interval.
Pillcam Colonoscopy: What did we learn?

- **ESGE 2012**
  - Average risk patients
  - Incomplete colonoscopy
  - Unwilling to undergo conventional colonoscopy
  - Colonoscopy contraindicated

- **FDA 2014**
  - Incomplete colonoscopy
  - Colonoscopy contraindicated

<table>
<thead>
<tr>
<th>For</th>
<th>Against</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient preference</td>
<td>Physician preference</td>
</tr>
<tr>
<td></td>
<td>Novelty</td>
</tr>
<tr>
<td></td>
<td>Training</td>
</tr>
<tr>
<td></td>
<td>Remuneration</td>
</tr>
<tr>
<td>Increased capacity</td>
<td>Increased work load</td>
</tr>
<tr>
<td>Pan-endoscopy</td>
<td>Histology</td>
</tr>
<tr>
<td>Non medical reading</td>
<td>Intervention</td>
</tr>
<tr>
<td>Increased access</td>
<td>Cost</td>
</tr>
<tr>
<td>Safety?</td>
<td>Time Lag</td>
</tr>
</tbody>
</table>
An expensive Selfi!!!!

Courtesy: Rami Eliakim
Mechanical Fold Flattening Approach

Cap assisted colonoscopy

Endocuff/Endoings Endoscopic Over tube

G-EYE™ Colonoscope
Cap-assisted colonoscopy and detection of Adenomatous Polyps (CAP) study: a randomized trial

Authors
Heiko Pohl¹,², Steve P. Benson², Arifa Toor², Stuart R. Gordon², L. Campbell Levy², Brian Berk², Peter B. Anderson², Joseph C. Anderson¹, Richard I. Rothstein², Todd A. MacKenzie³, Douglas J. Robertson¹

Patients consented and randomized n = 1148

Cap-assisted colonoscopy n = 575
Excluded:
Age (n = 1)
Fellow involvement (n = 11)
Other (n = 2) *

Standard colonoscopy n = 573
Excluded:
Age (n = 3)
IBD (n = 3)
Fellow involvement (n = 9)
Other (n = 6) *

Patients analyzed n = 561

ADR
42%

Patients analyzed n = 552

40%
Cap-Assisted Colonoscopy: A Meta-Analysis with Borderline Efficacy

Endpoint = Polyp Detection

RR (95% CI)
1.26 (1.02, 1.55)
1.20 (0.96, 1.51)
1.10 (1.01, 1.20)
1.02 (0.84, 1.23)
0.81 (0.68, 0.97)
0.95 (0.72, 1.25)
1.07 (0.59, 1.91)
1.05 (0.78, 1.40)
1.11 (0.94, 1.32)
1.28 (1.00, 1.63)
1.23 (1.06, 1.43)
1.00 (0.85, 1.19)
1.08 (1.00, 1.17)

Favors SC  Favors CAC

16 RCTs, n = 8,991

Cap-Assisted Colonoscopy: A Meta-Analysis with Borderline Efficacy

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1.28 (1.00, 1.63)
1.23 (1.06, 1.43)
1.00 (0.85, 1.19)
1.08 (1.00, 1.17)

NNT=13

16 RCTs, n= 8,991

NaviAid™ G-EYE™ Balloon-Colonoscope

- Pentax colonoscope with permanently integrated, reusable balloon
- Balloon inflated by the endoscopist (foot pedal) through the colonoscope internally, no external mounted accessories
- Cecum with balloon deflated
  - Balloon inflated to engage the colon walls & withdrawn
  - Mechanical straightening of folds & flexures
Comparison of adenoma detection and miss rates between a novel balloon colonoscope and standard colonoscopy: a randomized tandem study

Authors
Zamir Halpern, Seth A. Gross, Ian M. Gralnek, Beni Shpak, Mark Pochapin, Arthur Hoffman, Meir Mizrahi, Yosef S. Rochberger, Menachem Moshkowitz, Erwin Santo, Alaa Melhem, Roman Grinshpon, Jorge Pfefer, Ralf Kiesslich

126 patients enrolled

Group A (n = 60)
- 6 excluded: Insufficient bowel preparation (n = 4)
- Unexpected medical condition and pathological findings during procedure (n = 2)*
- 54 subjects included in the study analysis

Group B (n = 66)
- 14 excluded: Insufficient bowel preparation (n = 10)
- Unmet inclusion criteria (n = 1)
- Unexpected medical condition and pathological findings during procedure (n = 1)**
- Technical failure (n = 2)*
- 52 subjects included in the study analysis

Miss rate adenomas

44.7% ST
7.5% G-EYE
EndoCuff™
EndoCuff™

- RCT, 2 centers, n=498
- Colonoscopy with and without endocuff,
- EC - 63% more polyps detected
- PDR = EC 56% vs no EC 42%, p=0.001
- EC – significantly more polyps (<1cm) detected in cecum (p=0.001) and sigmoid (p=0.002)
- ADR significantly increased by 86% (P=0.002)
- No adverse events

EndoRings – CLEVER Study

- **RCT, N=116**  
  Dik, Siersema, Gralnek et al. (Endoscopy, 2015)

- **Tandem colonoscopy design,**

- **Study endpoint = adenoma miss rate**
  - With endorings = 15%
  - Without endorings = 48%, p < 0.01

- **Time to cecum (9.6 min vs. 8.1 min, p=0.17)**

- **Withdrawal times (7.2 vs. 6.8 min, p=0.14)**

- **No adverse events**
Prepless Capsule Colonoscopy: Ultra Low Dose X-ray-Based Imaging Technology (Check-Cap, Israel)

- **Ultra-low dose** (0.03 mSv)
- **Low energy** (56 – 70 Kev)

Moshkowitz, Gluk, Arber (Gut 2016)
#1 Case Study

Scanning Capsule finding:
- A polyp was detected approximately 17 cm above the caecum

Colonoscopy finding:
- A 12X4 mm flat sessile polyp on a haustra was detected 18 cm from the bottom part of the caecum
#2 Case Study

**Scanning Capsule finding:**
- A pedunculated two heads polyp in the sigmoid colon, measuring 7mm and 15mm

**Colonoscopy finding:**
- 35 cm from the anal verge a 30 mm pedunculated polyp with two heads.
### Outcome Studies

<table>
<thead>
<tr>
<th>Hooded colonoscope</th>
<th>Wide angle colonoscope</th>
<th>Third eye retroscope</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 randomized trials</td>
<td>10 randomized trials</td>
<td>A multicenter randomized tandem colonscopy study</td>
</tr>
<tr>
<td>Current evidence does not indicate any consistent improvement in adenoma detection by hooded colonoscopy</td>
<td>The only benefit observed was that some operators can withdraw faster without decreasing adenoma detection</td>
<td>No difference between third eye and conventional colonoscopy</td>
</tr>
</tbody>
</table>

Courtesy of Prof. Halpern
Improve Imaging
Optic Image

Standard Endoscopy (SD)
0.4 megapixel

High definition (HD)
1.2 megapixel

Magnifying colonoscopy
Zoom X300

Confocal Laser endomicroscopy
X1000
HD Colonoscopy - Meta-analysis

Subramanian et al. Endoscopy 2011
# HD Colonoscopy - Meta-analysis

<table>
<thead>
<tr>
<th>Polyps/total</th>
<th>Incremental yield (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD</td>
<td>SVE</td>
</tr>
<tr>
<td>47/58</td>
<td>57/72</td>
</tr>
<tr>
<td>134/310</td>
<td>119/310</td>
</tr>
<tr>
<td>170/428</td>
<td>157/428</td>
</tr>
<tr>
<td>508/1226</td>
<td>464/1204</td>
</tr>
<tr>
<td>123/193</td>
<td>104/197</td>
</tr>
</tbody>
</table>

| Adenoma/total |  |
| HD | SVE |
| 41/58  | 43/72 |  |
| 82/310  | 79/310 |  |
| 105/426  | 93/426 |  |
| 347/1226  | 298/1204 |  |
| 111/193  | 99/197 |  |

NNT=28

Subramanian et al. Endoscopy 2011
**HD vs SD**

Prevalence of at least one polyp in screening population: 58% (mainly hyperplastic)

Rex DK. Maximizing detection of adenomas and cancers during colonoscopy. Am J Gastroenterol 2006

---

**HD vs SD**

Retrospective study in routine practice. Difference between adenomas detection HD vs SC: 28.8% vs 24.3% (p=.012)

Buchner A. High definition colonoscopy detects colorectal polyps at a higher rate than standard white light colonoscopy. Clin Gastroenterol Hepatol 2010

---

**HD and wide angle vs SD**

The only controlled study. No difference between adenoma detection rate 45 vs 43% (p=.87)

Pellise M. Impact of wide-angle, high-definition endoscopy in the diagnosis of colorectal neoplasia: a randomized controlled trial. Gastroenterology 2008

*Courtesy of Prof. Halpern*
Optic Imaging

- The behavior of visible ultraviolet and infrared light omitted from a source [i.e. laser, xenon] to surface is variable.
- Light may interact with tissue in various ways that can be measured and analyzed.
- These interactions provide information about tissue type, Hb content, microstructure, and molecular characteristic.
Image Enhanced Endoscopy

Courtesy of Prof. Halpern
Chromoendoscopy

- **Absorptive stains**
  - Lugol’s solution
  - Methylene blue
  - Crystal violet
  - Acetic acid

- **Contrast stains**
  - Indigocarmine
Chromoendoscopy is Most Useful in the Evaluation of Nonpolypoid Colorectal Neoplasms (Kiesslich, Eur J Gastroenterol 2005)

Prevalence of flat adenomas:
without Chromoendoscopy 1-5%
with Chromoendoscopy 20-35%
Electronic Chromoendoscopy?

NBI

i-Scan

Subramanian et al. Clin Gastroenterol Hepatol 2013
ASGE Technology Committee. GIE 2015
NBI is equal to chromoendoscopy for distinguishing neoplastic from non-neoplastic lesions

Machida, Endoscopy 2004
Narrow Band Imaging (NBI)

Illumination

reflection

absorption  scattering

WLE  NBI
Conclusions:

- **NBI can distinguish between neoplastic and non-neoplastic colorectal lesions**
- The diagnostic accuracy of NBI is **better** than that of conventional colonoscopy and **equivalent** to that of chromoendoscopy.
Virtual Chromo (NBI) - Meta-analysis

- Endpoint = Adenoma detection rate

<table>
<thead>
<tr>
<th>Study ID</th>
<th>RR (95% CI)</th>
<th>Events, Treatment</th>
<th>Events, Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rex et al (2007)</td>
<td>0.97 (0.84, 1.11)</td>
<td>141/217</td>
<td>146/217</td>
</tr>
<tr>
<td>Adler et al (2008)</td>
<td>1.36 (0.91, 2.04)</td>
<td>45/198</td>
<td>33/198</td>
</tr>
<tr>
<td>Inoue et al (2008)</td>
<td>1.23 (0.89, 1.71)</td>
<td>51/122</td>
<td>41/121</td>
</tr>
<tr>
<td>Kaltenbach et al (2008)</td>
<td>1.15 (0.89, 1.47)</td>
<td>68/135</td>
<td>62/141</td>
</tr>
<tr>
<td>Adler et al (2009)</td>
<td>1.03 (0.84, 1.27)</td>
<td>140/625</td>
<td>137/631</td>
</tr>
<tr>
<td>Paggi et al (2009)</td>
<td>0.98 (0.78, 1.24)</td>
<td>59/103</td>
<td>63/108</td>
</tr>
<tr>
<td>Overall (I-squared = 0.4%, p = 0.413)</td>
<td>1.06 (0.97, 1.16)</td>
<td>504/1400</td>
<td>482/1416</td>
</tr>
</tbody>
</table>

*Dinesen L, et al. Gastrointest Endosc 2012*
Virtual Chromo (NBI) - Meta-analysis

Endpoint = Adenoma detection rate

No significant

Virtual Chromo (NBI) - Meta-analysis

- Endpoint = Mean adenoma per patient

Study ID

- Rex et al (2007)
- Adler et al (2009)
- Paggi et al (2009)
- Pisello et al (2009)

Overall (I-squared = 56.5%, p = 0.032)

WMD (95% CI)

-0.02 (-0.18, 0.13)
0.07 (-0.04, 0.18)
0.30 (0.09, 0.51)
0.25 (0.02, 0.48)
-0.02 (-0.09, 0.04)
0.12 (-0.25, 0.49)
0.03 (-0.32, 0.39)
0.08 (-0.02, 0.17)

NOTE: Weights are from random effects analysis

Virtual Chromo (NBI) - Meta-analysis

- Endpoint = Mean adenoma per patient

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<td>Overall (I-squared = 56.5%, p= 0.032)</td>
<td>0.08 (-0.02, 0.17)</td>
</tr>
</tbody>
</table>

NOTE: Weights are from random effects analysis

i-Scan & FICE

Illumination

Computed Virtual Chromoendoscopy: "Photoshop"

absorption scattering

Courtesy of Prof. Halpern
iScan

Contrast enhancement (CE)

Surface enhancement (SE)

Tone enhancement (TE)

Courtesy of Prof. Halpern
Does I-scan Increase Adenoma Detection?

Hoffman, DDW 2009

- I-scan vs CC for detection & classification of polyps (100 vs 100 pts)
- Detected patients with ≥ 1 adenoma 38 vs 18 (sign. increase)

Possibly, but not enough data

Courtesy of Prof. Halpern
Fujinon Intelligent ChromoEndoscopy (FICE)

What is FICE

Fuji Intelligent Chromo Endoscopy

Processor EPX-4400

Conventional image

Spectral Estimation technique

Different structural images depending on wavelength are obtained.

Free selection of 3 kinds of wavelength

The reconstructed result

Courtesy of Prof. Halpern
Does FICE Increase Adenoma Detection?

- **FICE vs CC with targeted chromo 368 vs 396 pts**
- **No difference:** adenomas 236 vs 271 \( (p=0.92) \)
- **FICE vs WLE in 63 pats**

Detected adenomas 42 vs 43 \( (p=0.89) \)

**Probably not..**

*Pohl, Gut 2008 Cha, Dig Dis Sci 2009*
Comparison of detection and miss rates of narrow band imaging, flexible spectral imaging chromoendoscopy and white light at screening colonoscopy: a randomised controlled back-to-back study

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ADR

24%

23%

25%
Novel Technology

- Study design (tandem studies)
- Publication bias

Additional studies are needed!

DK Rex, DDW 2015, Washington DC
The Future is Molecular Imaging

Improved detection of tumor location

Malignant Vs Benign

Tumor Margins

Pharmacologic al therapy [response]

Minimize number of biopsy

Dysplasia in inflamed mucosa
mAb to CD24 concentrate in CRC in nude mice (Arber’s lab)
Molecular confocal laser endomicroscopy against EGFR using cetuximab identified metastases in the liver of xenografted nude mice (a). Individual tumor cells could be visualized (arrows), surrounded by healthy liver tissue. These findings could be verified ex vivo (b).
In vivo imaging using fluorescent antibodies to tumor necrosis factor predicts therapeutic response in Crohn’s disease

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Summary

1. Colonoscopy is the gold standard

2. But.....we need to do even better

3. Exciting novel technologies are available and many more are emerging

4. Meticulous colonoscopy performance is crucial and still the most important parameter

5. Ease of use, effectiveness, economics of new technology will determine uptake in practice